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Signature of Sender:

Paul Vincent

Name of Sender:

PAUL VINCENT

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	KLEIN, Gerhard) Examiner:
Application No.:	10/517,379) unknown
PCT Filing Date:	January 16, 2003) Art Unit:
For:	MACHINE FOR SUPERFINISHING) unknown
	BY HONING)

Atty. Docket No.: 2213 0084US

**TRANSMITTAL LETTER REQUESTING WITHDRAWAL OF
APPLICATION AND REFUND OF FEES**

PCT LEGAL ADMINISTRATION

Commissioner for Patents

Alexandria, VA 22313-1450

U.S.A.

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Transmitted herewith is a request for withdrawal of the subject application and refund of fees. Please note the following crossed items:

- () A copy of the Notification of Missing Requirements is enclosed.
- () An Assignment of Invention to
- () Declaration
- () A Petition for Extension of time under 37 CFR 1.136(a)
- () Please charge Deposit Account Number 50-1030 in the amount of \$ 130 for the fee under 37 CFR 1.492(e).
- () The Commissioner is hereby authorized to charge payment of fees associated with this communication or credit any overpayment to Deposit Account Number 50-1030.
- () Applicant believes that no extension of term is required. However, this conditional petition is being made to provide for the possibility that applicant has inadvertently overlooked the need for a petition and fee for extension of time.
- () Return Postcard Receipt

Please send all correspondence to customer number 29894

Respectfully submitted

Paul Vincent

Dr. Paul Vincent
Reg. No. 37,461

January 31, 2005

Date

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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	KLEIN, Gerhard) Examiner:
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U.S.A.

**REQUEST FOR WITHDRAWAL OF APPLICATION AND REFUND OF
FEES**

This is a request for withdrawal of the above referenced nationalized PCT application and refund of the nationalization fees.

STATEMENT OF FACTS

On December 6, 2004 the Applicant mailed a request for nationalization of PCT/EP03/00379 using Fedex courier. On December 08, 2004 the Applicant's routine check of the mailing via the Fedex Internet tracking web site failed to indicate any record of the mailing. The Applicant immediately phoned Fedex and requested a search. Since the deadline for nationalization was December 10, 2004, and fearing that the original mailing had become lost, the Applicant mailed a second substantially identical request for nationalization of the subject PCT application on December 08, 2004. On December 8, 2004 the Applicant received a call from Fedex stating that the first mailing had been located and was being sent to the USPTO. On December 9, 2004 the first mailing was received by the USPTO and assigned application number 10/517,276. On December 10, 2004, the second mailing was received by the USPTO and assigned application number 10/517,379. On December 15, 2004 the USPTO deducted \$1000 from the deposit account of the Applicant (account number 50-1030) for nationalization of the '276 application. On December 16, 2004 the USPTO deducted \$1000 from the deposit account of the Applicant for nationalization of the '379 application.

EVIDENCE IN SUPPORT OF THESE FACTS

Enclosed is copy of the Deposit Account statement of the Applicant for December 2004 indicating deduction of the nationalization fees for the two requests.

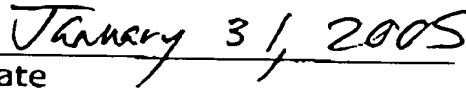
SUMMARY AND REQUESTS

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The Applicant requests withdrawal of application 10/517,379 and refund of the Nationalization fees, since the USPTO is only entitled to one fee for the nationalization of a PCT application.



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United States
Patent and
Trademark Office

Deposit Account Statement

Requested Statement Month:

December 2004

Deposit Account Number:

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Name:

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12/10	289	10516916	1703 1326US	1613	\$950.00	\$23,562.00
12/10	290	10516916	1703 1326US	1615	\$126.00	\$23,436.00
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12/23	142	10517870	1703 1333US	1632	\$500.00	\$14,747.00
12/23	143	10517870	1703 1333US	1633	\$200.00	\$14,547.00
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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER

2213 0084US

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US).
CONCERNING A FILING UNDER 35 U.S.C. 371**

U.S. APPLICATION NO

10/517379INTERNATIONAL APPLICATION NO.
PCT/EP03/00379INTERNATIONAL FILING DATE
January 16, 2003PRIORITY DATE CLAIMED
June 10, 2002

TITLE OF INVENTION: MACHINE FOR SUPERFINISHING BY HONING

APPLICANT(S) FOR DO/EO/US

KLEIN, Gerhard

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a FIRST submission of items concerning a filing under 35 U.S.C. 371
2. ☐ This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371
3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1)
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C.371(c)(2)).
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C.371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C.371(c)(3)).
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☒ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C.371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C.371(c)(4)).
10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C.371(c)(5)).

Items 11. to 16. below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:

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10/517379

U.S. APPLICATION NO		INTERNATIONAL APPLICATION NO PCT/EP03/00379		ATTORNEYS DOCKET NUMBER 2213 0084US	
17. The following fees are submitted:				CALCULATIONS PTO USC Only	
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1)-(5)): Search Report has been prepared by the EPO or JPO.....\$ 950.00 International preliminary examination fee paid to USPTO\$750.00 No international preliminary examination fee paid to USPTO but international search fee paid to USPTO.....\$790.00 Neither international preliminary examination fee nor international search fee paid to USPTO.....\$1110.00 International preliminary examination fee paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4).....\$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT =					
Surcharge of \$130.00 for furnishing the oath or declaration later than <u>20</u> <u>30</u> months from the earliest claimed priority date (37 CFR 1.492(e)).					
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	3 -20 =	0	X \$ 18.00	\$	
Independent claims	1 - 3 =	0	X \$ 88.00	\$	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)				+	\$ 300
TOTAL OF ABOVE CALCULATIONS				=	\$ 950
Reduction by 1/2 for filing by small entity, if applicable.				\$	
SUBTOTAL				=	\$ 950
Processing fee of \$130.00 for furnishing the English translation later than <u>20</u> <u>30</u> months from the earliest claimed priority date (37 CFR 1.492(f)).				+	\$
TOTAL NATIONAL FEE				=	\$ 950
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	
TOTAL FEES ENCLOSED				=	\$ 950
				Amount to be:	
				refunded \$	
				charged \$	
a. <u> </u> A check in the amount of \$ <u> </u> to cover the above fees is enclosed. b. <u>X</u> Please charge my Deposit Account No. <u>50 1030</u> in the amount of \$ <u>950</u> to cover the above fees. c. <u>X</u> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>50 1030</u> . A duplicate copy of this sheet is enclosed. NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status. Please send all correspondence to: Customer Number 29894 Dr. Paul J. Vincent Dreiss, Fuhlendorf, Steimle & Becker Postfach 10 37 62 D-70032 Stuttgart Fed.Rep. of Germany					
SIGNATURE:		<u>Paul Vincent</u>			
DATE:		<u>December 8, 2004</u>			
NAME		<u>Dr. Paul J. Vincent</u>			
REGISTRATION NUMBER		<u>37,461</u>			

1517379
DT09 Rec'd PCT/PTO 10 DEC 2004

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	KLEIN, Gerhard) Examiner:
PCT Application No.:	PCT/EP03/00379) unknown
PCT Filing Date:	January 16, 2003) Art Unit:
For:	MACHINE FOR SUPERFINISHING) unknown
	BY HONING)

Atty. Docket No.: 2213 0084US

MAIL STOP PCT

Commissioner for Patents

Alexandria, VA 22313-1450

U.S.A.

PRELIMINARY AMENDMENT

Please enter this amendment prior to calculation of the filing fees.

This amendment is based on the translation of the application as

amended under Article 19 on July 04, 2003. Please enter

that amendment before entering this Preliminary

Amendment.

SPECIFICATION AMENDMENTS:

On page 1, replace, between the title and the first paragraph "Description" with --

This application is the national stage of PCT/EP03/00379 filed on January 16, 2003 and also claims Paris Convention priority of DE 102 25 514.8 filed on June 10, 2002.

BACKGROUND OF THE INVENTION --:

On page 1, amend paragraph one as follows--

The invention concerns a machine for superfinishing workpieces by honing or precision grinding according to ~~the preamble of claim 1~~ the independent claim. --.

On page 2, insert as a title prior to the third paragraph

-- SUMMARY OF THE INVENTION --. :

Amend the third paragraph on page 2 as follows--

This object is achieved in accordance with the invention with the ~~means stated~~ elements recited in the ~~characterizing part of the claims~~. --.

On page 3 insert as a title prior to the brief description of the drawing --

BRIEF DESCRIPTION OF THE DRAWING --.

On page 4 insert as a title following the brief description of the drawing

--

DESCRIPTION OF THE PREFERRED EMBODIMENT --.

On page 11 replace as a title on line one "Claims" with

-- I CLAIM: --

CLAIM AMENDMENTS:

1-3 cancelled.

4. (new) A machine for superfinishing tools through honing or precision grinding, the machine comprising:

- a spindle housing;
- a honing spindle disposed in said spindle housing;
- a first electromotor having a stator integrated in said spindle housing and a rotor borne for rotation within said stator, said rotor surrounding and rotating said honing spindle;
- a linear motor having a moving part bearing said spindle housing for controlling a stroke motion of said honing spindle;
- a bar disposed within said honing spindle for rotation therewith;
- a second electromotor coaxially flanged to an end of said spindle housing, said second electromotor communicating with said bar for axial displacement thereof to widen a honing tool disposed on said honing spindle or to carry a grinding body.

5. (new) The machine of claim 4, wherein said second electromotor comprises a driven shaft which engages in a coupling piece and rotates same, said coupling piece comprising a plunger provided with an outer thread which engages in an inner thread of an adjusting sleeve which is axially displaced upon rotation of said coupling piece due to engagement of said inner and outer threads and to which a further sleeve is connected for axial displacement within a transmission housing without rotating, wherein a

connecting rod which can be connected to said bar is rotatably disposed in said further sleeve.

6. (new) The machine of claim 4, wherein said second electromotor comprises a linear motor whose runner and stator are round, wherein said runner is disposed in said stator to communicate with said bar.

Remarks

The amendments have been taken to adapt this application to United States practice. No new matter has been added.



Paul Vincent

Dr. Paul Vincent

Agent for the Applicant

Reg. No. 37,461

December 8, 2004

Date

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2213 0084US

Machine for Superfinishing by Honing

Description

The invention concerns a machine for superfinishing workpieces by honing or precision grinding according to the preamble of claim 1.

Honing machines are used for the above-mentioned tasks. A honing tool is provided with an appropriate coating (e.g. of diamond or corundum) and is introduced into a bore while simultaneously being turned and reciprocated to process the inner surface of the bore. To take into account the wear of the honing tools, these are i.a. designed to have honing strips provided with a honing layer which can be adjusted in a radial direction by means of a widening bar which rotates along with the honing tool but can be displaced therein in an axial direction.

Machines can moreover be used, with which a tool must be mounted to the device in a direction which corresponds to the axial direction of the rotational motion of the machine. These may be honing tools (e.g. for so-called "mandrel honing") and also lapping tools. They could also be precision grinding tools to subject e.g. pre-ground valve seat surfaces to final superfinishing, wherein only a few micrometers must be removed in an exactly defined manner thereby simultaneously improving the surface.

The lifting motion of the carriage supporting the honing spindle of honing machines has generally been conventionally effected via a hydraulic drive, while the rotational motion of the honing spindle and thereby also that of the honing tool disposed therein, is effected by a common electromotor. The simultaneous rotational and lifting motions of the

honing tool during honing produces a cross-grinding pattern on the surface to be processed, which is typical for this type of treatment, this pattern being important for the bearing and lubricating properties of the processed workpiece and also for the fitting accuracy of further components (e.g. pistons). For processing smaller bores having a diameter of only a few millimeters and simultaneous increase of the rotational speed of the honing tool to reduce the processing time, the stroke speed must be correspondingly increased. The hydraulic drives used to provide the stroke motion are thereby limited with regard to speed and reversibility of the system during operation. This is particularly true when the strokes are short as is the case when the processing depth of the bores is in the range of a few millimeters.

It is the underlying purpose of the invention to eliminate these disadvantages. In particular, means should be provided for the stroke motion which permit higher stroke speeds while thereby maintaining high reversal accuracy to ensure that small and short bores can also be processed more exactly and rapidly at higher honing tool rotational speeds. This object also addresses the problem of exactly realizing very short delivery paths for the carriage supporting the honing spindle, such as those which occur e.g. during precision grinding of valve seat surfaces. Moreover, the entire construction should be simplified by reducing the number of moving parts thereby also reducing costs.

This object is achieved in accordance with the invention with the means stated in the characterizing part of the claims.

A so-called linear motor is used which permits higher lifting and delivery speeds, has considerably less components, can be reversed with more precision and allows short stroke paths at high speed.

The use as honing machine, i.e. use of a honing tool with radially adjustable honing strips, is facilitated in that the widening bar for radial adjustment of the honing strips, which is actuated by a connecting rod disposed in the honing machine, can also be actuated in a more simplified manner using a servomotor which, in turn, may preferably be flanged coaxially to the coupling housing and disposed as a linear extension to the spindle housing. The connecting rod can also be preferably adjusted via a further linear drive. The invention may then also be used to perform a rapid and precise, minimum, exactly defined, stroke motion of a precision grinding tool, e.g. for processing a valve seat.

Embodiments of the invention are described in more detail below with reference to the enclosed drawings.

Fig. 1 shows a schematic view of a honing machine which is designed in accordance with an embodiment of the invention;

Fig. 2 shows a honing spindle housing 8 of the honing spindle 7, the carriage 12 and the sliding rails 14 as well as the carrier 15 carrying the sliding rails 14 and disposed on the machine frame 16, the view being tilted by 90° with respect to Fig. 1;

Fig. 3 shows a view in the direction of the arrows III-III of Fig. 2;

Fig. 4 shows a section through the spindle housing 8;

Fig. 5 shows a section through the coupling housing 51 which is flanged to the spindle housing 8;

Fig. 6 shows a section through the coupling housing 51 of a second embodiment of the invention which is suited, in particular, for small stroke motion in an axial direction;

Fig. 7 shows a view in the direction of arrows VII-VII of Fig. 6;

Fig. 8 shows a schematic representation of a workpiece 301 and an associated tool 300 which can be used with the embodiment of Figs. 6 and 7.

Fig. 1 shows a honing machine. A workpiece 2 is clamped on a processing platform 1 for honing a bore 3 thereof. The honing tool 4 which is received in a cone 6 at the end of the honing spindle 7 is lifted and lowered with the honing spindle 7 thereby providing the conventional stroke motion of the honing process, as is part of the honing method. The axial displacement of the honing spindle 7 serves to generate this stroke motion. The honing tool 4 has radially adjustable honing strips 5. The honing spindle 7 is driven by an electromotor 9 which is integrated in the spindle housing 8. A coupling housing 51 is flanged to the upper end (in Fig. 1) of the spindle housing 8, and a servomotor 10 is coaxially flanged to the coupling housing 51. The servomotor 10 provides axial displacement of a widening bar 11 which is disposed in the honing tool 4 and passes through the rotating honing spindle 7 for radial adjustment of the honing strips 5.

The spindle housing 8 is disposed on a carriage 12 in which the primary part 13 of a linear motor is integrated. The primary part 13 forms a linear motor 18 together with the secondary part 17 which is integrated in the vertically extending carrier 15 (see Fig. 3). This linear motor 18 effects the lifting motion of the spindle housing 8. The carrier 15 is mounted to the machine frame 16. The carriage 12 with integrated primary part 13

can be lifted and lowered on the sliding rails 14, which, in turn, are fixed to the carrier 15. The primary part 13 is the moving part and the secondary part 17 is the stationary part of the linear motor 18.

Use of a linear motor whose moving part carries the honing spindle and thereby performs the stroke motion with the required speed and reversal accuracy is of primary importance to the invention. To process the bore 3, the spindle housing 8, including honing spindle 7 and honing tool 4 received therein, is lowered to such an extent that the honing strips 5 penetrate into the bore 3. The honing spindle 8 is simultaneously reciprocated (lifted and lowered) and turned. These two motions are matched to generate the "cross-grinding pattern", which is typical for honing, on the workpiece surface at an angle of e.g. 10° to 50° . For smaller diameters of the bore to be processed and high rotational speeds, this pattern requires a relatively fast lifting and lowering of the honing spindle 8, which is ensured by the linear motor 18. An inventive honing machine with e.g. a stroke of 80mm can have a stroke speed of 50m/min with a reversal accuracy of ≤ 0.05 mm (reversal is the change of motion from one direction to the opposite direction). With a stroke of 20mm, it can have a stroke speed of 25m/min with a reversal accuracy of ≤ 0.04 mm.

As is shown in Fig. 3, the primary part 13 of the linear motor 18 is mounted to the carrier 15 via screws 19 and the sliding rails 14 are mounted to the carrier 15 via screws 20. The profile of the sliding rails 14 corresponds to the profile of the sliding elements 21, which are mounted to the carriage 12 via screws 22. The primary part 13 of the linear motor 18 is mounted in the carriage 12 via screws 23.

The person skilled in the art is familiar with linear motor construction and an exact description is therefore unnecessary herein. Linear motors can

be obtained from various manufacturers. They are driving elements which are developed from a normal rotary current electromotor by "cutting open" the stator and unfolding it into a plane. The rotor is also planar such that it moves along the linear extension of the stator in correspondence with the alternating electromagnetic field which propagates along the windings of the stator. In the present case, the primary part 13 corresponds to the stator, the secondary part 17 to the rotor of an electromotor. It is a synchronous device and is designed as a long stator motor. The speed is controlled via frequency variation in a frequency converter of an associated control. A programmable control (not shown) permits adjustment of corresponding speed as stated above.

A carrier frame 171 is mounted on the carrier 15 using screws 170, only one of which is visible, and a measurement transducer 173 is disposed on the carrier frame 171 via screws 172. It contains conventional measurement markings (not shown) which generate measuring signals in sensors (not shown) disposed on the carriage during motion of the carriage 12 perpendicular to the plane of the drawing of Fig. 3, the measuring signals showing the instantaneous position of the carriage 12 and transmitting it to the control (not shown). 174 designates a cover plate.

The structure of the spindle housing 8 is shown in Fig. 4. The electromotor 9 is integrated in the spindle housing 8. It causes rotation of the honing spindle and consists of a stator 25 with windings 25' and rotor 26. The stator 25 is pressed into a sleeve 37 which is screwed to the end plates 33, 34 using screws 36 (only shown at 34). The rotor 26 is pressed onto the outside of the honing spindle 7. The stator 25 is supplied with current via the connections 27. The rotor 26 is a permanent magnet. The spindle housing 8 is screwed to the carriage 12 using screws 30. The honing spindle 7 is supported in the spindle housing 8 via

bearings 31 or 32 in a front or rear end plate 33 or 34. The end plates 33 or 34 are screwed to the spindle housing 8 using screws 35. The sleeve 37 has a spiral cooling channel 38 which is supplied with coolant via the coolant delivery line 39. The coolant discharge is not shown: it is disposed on the opposite side.

The radial coupling housing 51 which joins the connecting plate 34 on the left-hand side, and the servomotor 10 which adjusts the widening bar 11 of the honing strips 5 of the honing tool 4 are shown in Figs. 4 and 5.

The honing spindle 7 has a continuous bore 40 in which the connecting rod 110 is disposed to be displaceable in an axial direction. The right-hand end of the connecting rod 110 has a bore 112 with inner thread into which the widening bar 11 is rigidly screwed, such that the connecting rod 110 and the widening bar 11 form a unit and can be commonly displaced in the longitudinal direction (axial direction) of the axis of rotation. The honing strips 5 are thereby radially displaced towards the outside. Honing tools 4 of this type are known in the art. During operation, the honing strips are radially pulled inward through springs and have inclined adjustment surfaces on their inner sides which cooperate with correspondingly inclined adjustment surfaces at the end of the widening bar 11 such that, when the widening bar 11 is axially displaced, the honing strips 5 are radially adjusted (spreading mechanism).

The connecting rod 110 and the widening bar 11 rotate together with the honing spindle 7 but can also be axially displaced therein (in the longitudinal direction) as mentioned above. This is realized in that the connecting rod 110 is penetrated by a pin 46 whose ends are guided in opposite grooves 46' in the honing spindle 7. The bore 40 in the honing spindle 7 has a shoulder 43 onto which a ring 41 is urged via a spring 45

which is supported with its other end on the pin 46. At rest, the connecting rod 110 is forced by the spring 45 in its outermost upper position shown in Fig. 4. The connecting rod 110 may then be downwardly displaced against the force of the spring 45, i.e. when the plunger 47 has been sufficiently moved downwards such that it urges the bottom 48' of the recess 48 downwardly. The connecting rod 110 is then also pressed downwards.

The plunger 47 is a continuation of a coupling piece 49 into the axial recess 49' of which the driven shaft 150 of the servo motor 10 projects. Coupling in the rotational direction with simultaneous displaceability in the longitudinal direction is realized by a tongue/groove connection formed by a groove 151 and wedge ("spring") 152.

The coupling housing 51 is screwed to the front end plate 34 of the spindle housing 8. The screws are not shown. A sleeve 52 is inserted into the coupling housing 51. The sleeve 52 rotates together with the coupling housing 51 and can be axially displaced therein, since a block 160 which is screwed into the sleeve 52 and radially projects past it, projects into a groove 161 in the sleeve 53 and is guided therein. The sleeve 52 can be displaced relative to the coupling housing 51 through a stroke H. The upper end of the connecting rod 110 is rotatably disposed in the sleeve 52 using bearings 165. The inner shells of the bearings 165 are rigidly connected to the connecting rod. A lid 166 is screwed to the connecting rod 110 to fix the bearing 165.

The sleeve 52 also receives an adjusting sleeve 53 which rotates therewith and can be displaced and adjusted in a longitudinal direction. This connection is also realized through a tongue and groove connection which is formed by the wedge 54 and the groove 55. The adjustment sleeve 53 is penetrated by a bore which has an inner thread 56. An outer

thread 56' of the plunger 47 engages therein. The adjustment sleeve 53 is secured in the sleeve 52 through a lid 167 which is screwed to the sleeve 52. If the servomotor 10 and thereby also its driven shaft 150 rotate, the coupling piece 49 is also rotated due to the tongue and groove connection 151, 152. Due to engagement of the threads 56, 56', the coupling piece 49 is displaced in an axial direction and the plunger 47 is moved in a longitudinal direction (to the right). When the plunger 47 is forced against the bottom 48' of the recess 48, the connecting rod 110 together with the widening bar 11 are displaced to the right-hand side against the force of the spring 45, thereby effecting radial adjustment of the honing strips 5 within the honing tool 4 as mentioned above.

170 is a sensor having an end switch which transmits the shown end position consisting of sleeve 52, block 160, bearing 165 and connecting rod 110, and a corresponding measured signal to the control (not shown).

A further embodiment is described below with reference to Figs. 6 and 7. The servomotor 10 is replaced by a linear motor and supplies a superfinishing tool 30 which is disposed at the end of the bar 306. It is connected to the connecting rod 120. The connecting rod 120 is rotatably disposed in the adjustment sleeve 253 using bearings 265, wherein the lid 266 is screwed into the adjustment sleeve 253 such that the connecting rod 120 can be rotated in the adjustment sleeve 253 but not be displaced in an axial direction thereto. The runner, i.e. the movable primary part 201 of a further linear motor 200 is rigidly connected to the adjusting sleeve 253. The linear motor 200 also has a secondary part (not shown). It is a construction type of a linear motor, wherein the runner is round and the inner space of the stator is also round. Such construction types of linear motors are also known per se. It is clear that the use of a linear motor requires much less components, including those

for the adjustment motion of the connecting rod 110 and of the bar 306 connected thereto. Moreover, these components are subjected to much less wear. Fig. 7 shows suspension of this further linear motor 200 using a clamping plate 210.

The embodiment with axial delivery of the bar 306 in accordance with Figs. 6 and 7 addresses a processing task which is explained by means of Fig. 8. The tool is a conical precision grinding body 300 which serves for processing a valve seat surface 305. The valve seat surface 305 must thereby be removed by a defined amount, e.g. a few hundredths of a millimeter, which is calculated e.g. using a sensor. Shape and surface must be simultaneously improved. The conical precision grinding body 300 is disposed on the bar 306 which has a threaded pin 307 at its end which is connected to the end of the connecting rod 120. In this manner, minimum stroke paths can be realized by means of the servomotor 10 or the further linear motor 200. This may be effected either with one stroke motion or several small stroke motions which are intermittently applied, e.g. for sparking out after only relatively few rotations or for rinsing with coolant after each stroke.

Claims

1. Machine for superfinishing workpieces through honing or precision grinding with a tool spindle which can be rotationally driven and can receive a tool, and a motor for rotating the tool spindle, wherein the tool spindle is disposed on a carriage which is disposed on a machine frame, and can be displaced in the direction of the axis of rotation of the tool spindle via an adjusting device, characterized in that the adjusting device comprises a linear electric motor (18) having a flat primary part (13) and a secondary part (17) disposed thereon such that it can be linearly displaced, wherein one (13) of the primary part/secondary part (13, 17) components of the linear motor (18) is disposed on the machine frame (16) and the other component is disposed on the carriage (12) bearing the tool spindle (7).
2. Machine for superfinishing workpieces through honing or precision grinding according to claim 1, characterized in that the linear motor (18) is a frequency-controlled synchronous motor whose primary part (13) is formed as a stator and whose secondary part (17) is formed by a permanent magnet, wherein the secondary part (17) is integrated in the carriage (12) bearing the tool spindle (7), with the speed being controlled through frequency conversion.
3. Machine for superfinishing workpieces through honing or precision grinding according to claim 1 or 2, characterized in that the tool spindle (7) is driven by an electromotor (9) formed by a stator (25) and rotor (26), wherein the stator is disposed in the tool spindle housing (8) supported on the carriage (12) and the rotor (26) is disposed on the outside on the tool spindle (7) and within the stator (25).

4. Machine for superfinishing workpieces through honing or precision grinding according to any one of the claims 1 through 3, characterized in that for delivering a processing body (5; 300) of the tool (4; 306) onto the surface of the workpiece (3; 301) to be processed, a connecting rod (110) is disposed within the tool spindle (7) to co-rotate and be displaceable in the direction of the axis of rotation (A), and displacement of the connecting rod (110) is realized by an electric servomotor (10) which is flanged to the spindle housing (8) comprising the tool spindle (7), and a transmission (47, 49, 53) is provided between the servo motor (10) and the connecting rod (110) which converts the rotary motion of the servomotor (10) into a linear adjustment motion of the connecting rod (110).
5. Machine for superfinishing workpieces through honing or precision grinding according to claim 4, characterized in that the servomotor (10) is disposed coaxially with respect to the axis of rotation (A) of the tool spindle (7).
6. Machine for superfinishing workpieces through honing or precision grinding according to claim 4 or 5, characterized in that the driven shaft (150) of the servomotor (10) rotates a coupling piece (49) which has a section (47) which is provided with a thread (56') which cooperates with the thread (56) of an adjusting sleeve (53) which cannot be rotated but can be displaced in a longitudinal direction to displace the coupling piece (49) in a longitudinal direction upon rotation of the driven shaft (150).
7. Machine for superfinishing workpieces through honing or precision grinding according to any one of the claims 1 through 3,

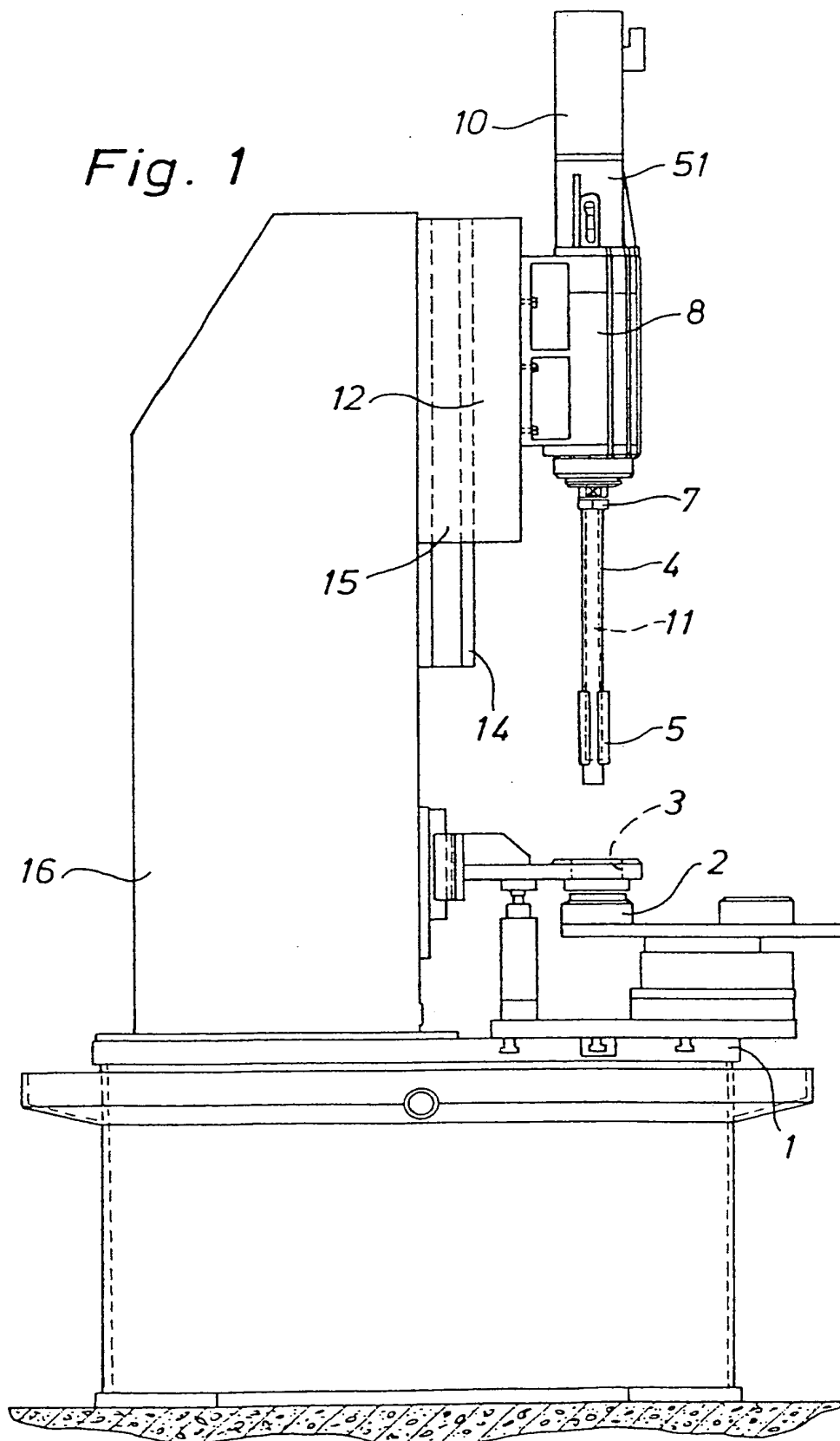
characterized in that a connecting rod (120) is disposed within the tool spindle (7) which co-rotates and is disposed to be displaceable in the direction of the axis of rotation (A) for delivering a tool (300) onto the surface (305) of the workpiece (301) to be processed, wherein the connecting rod (120) is displaced by a further linear motor (200) whose runner (201) acts on an adjusting sleeve (253) which can be displaced in the longitudinal direction but not be rotated within a coupling housing (51) disposed on the spindle housing (8), the adjusting sleeve (253) receiving the connecting rod (120) such that it can be rotated but not displaced.

8. Machine for superfinishing workpieces through honing or precision grinding according to claim 7, characterized in that the further linear motor (200) is received in a clamping plate (210) which is flanged to a linear extension of the coupling housing (51).
9. Machine according to any one of the claims 4 through 8, characterized in that the tool is a honing tool (4) which comprises radially adjustable honing strips (5) which are adjusted through a widening bar (11) which is coupled to the connecting rod (110).
10. Machine according to any one of the claims 7 or 8, characterized in that the tool coupled to the connecting rod (120) is a precision grinding tool (300) which engages with the workpiece (301) in the direction of longitudinal displacement of the connecting rod (120) and the precision grinding tool (300) is coupled to the connecting rod (120) in the direction of engagement with the workpiece (301).

Abstract

A honing machine for super finishing workpieces, e.g. by honing using a tool spindle (7), can be rotatably driven and can receive a tool. A motor rotates the tool spindle, the tool spindle (12) being arranged on a carriage (12), which can be displaced on a machine frame (16), by means of a drive device, in the direction of the rotational axis of the tool spindle. The drive device consists of a flat primary part (13) and a secondary part (17) of an electric linear motor (18), the secondary part being linearly displaceable along the primary part. One (13) of the components primary part/secondary part (13, 17) of the linear motor (18) is disposed on the machine frame (16), and the other (17) on the carriage (12).

Fig. 1



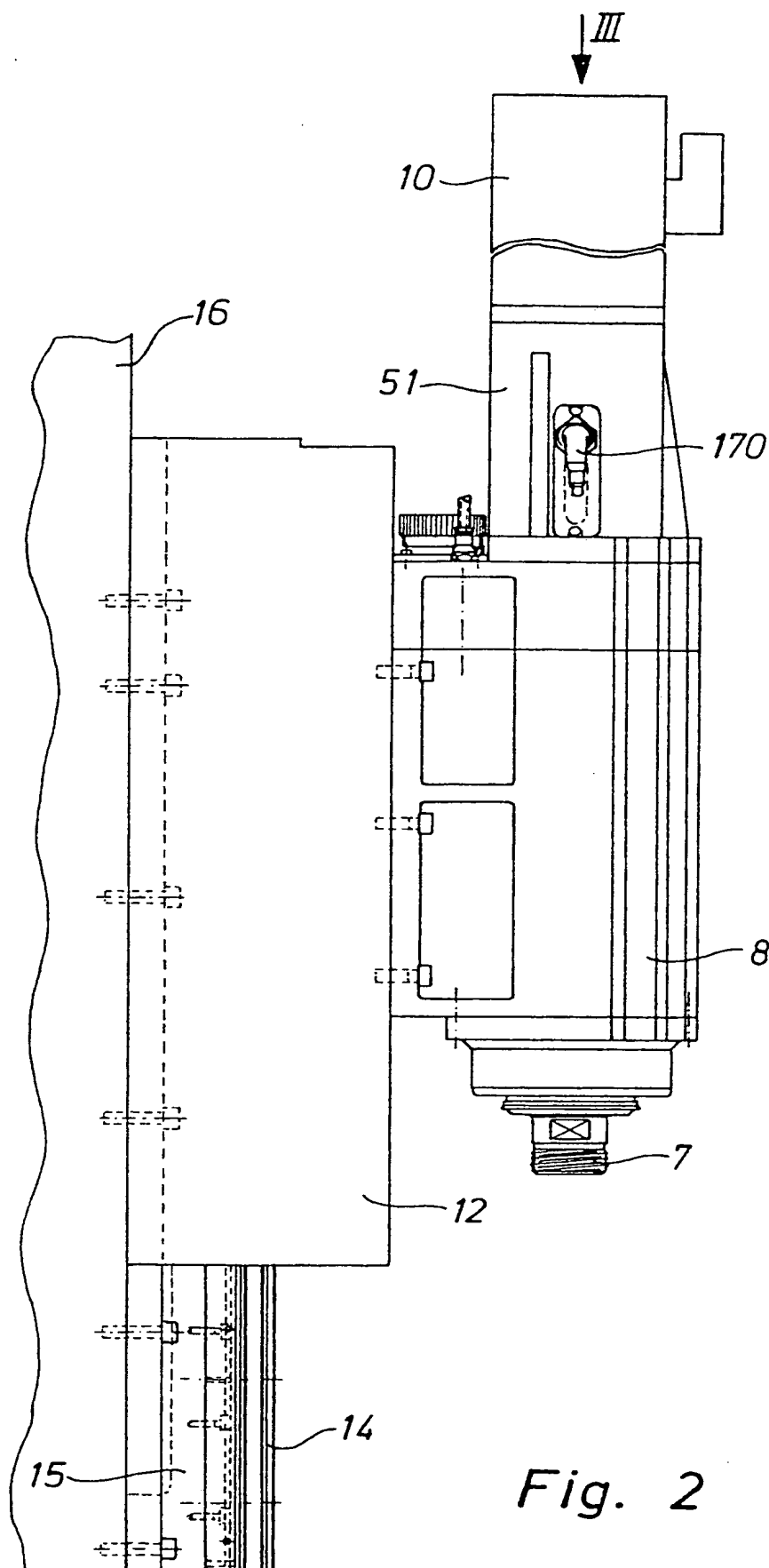


Fig. 2

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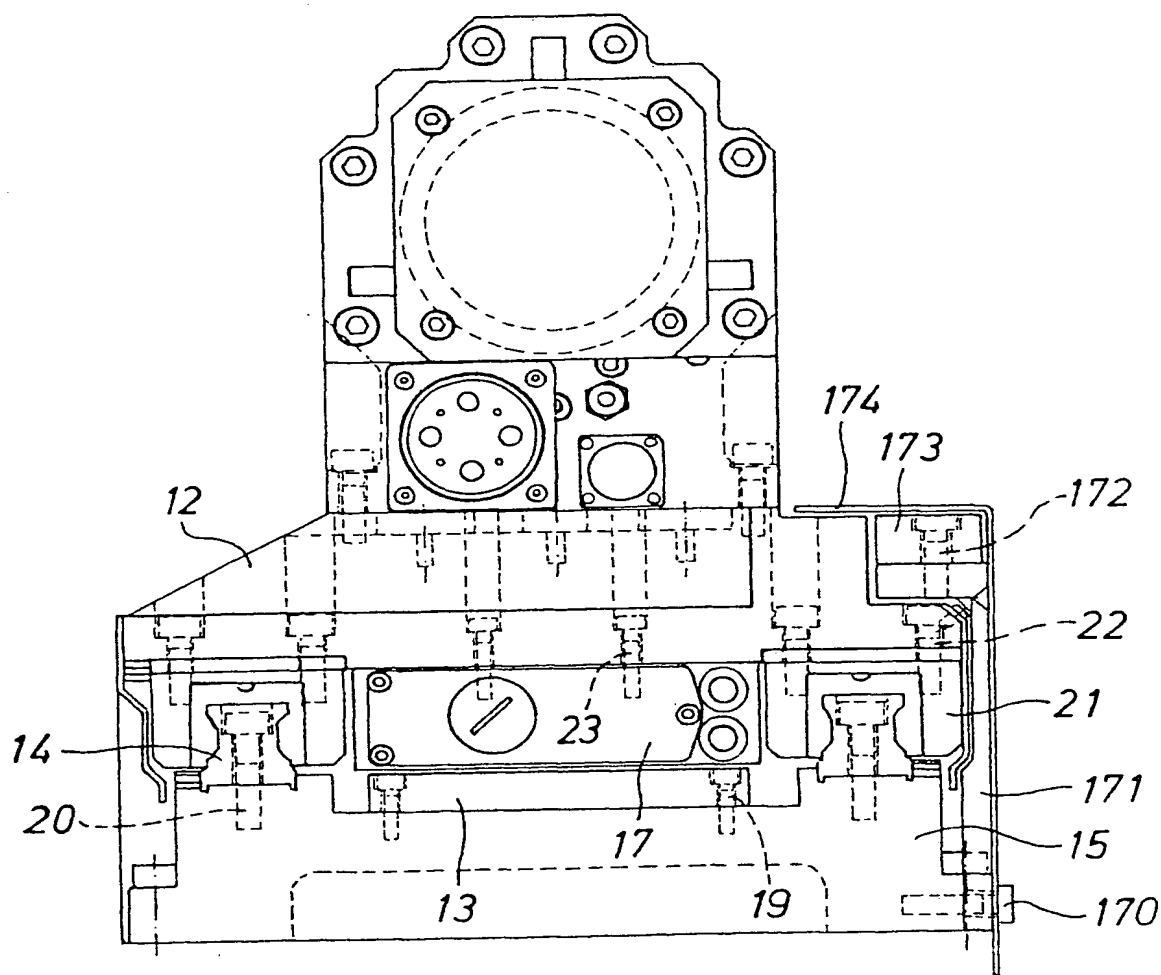


Fig. 3

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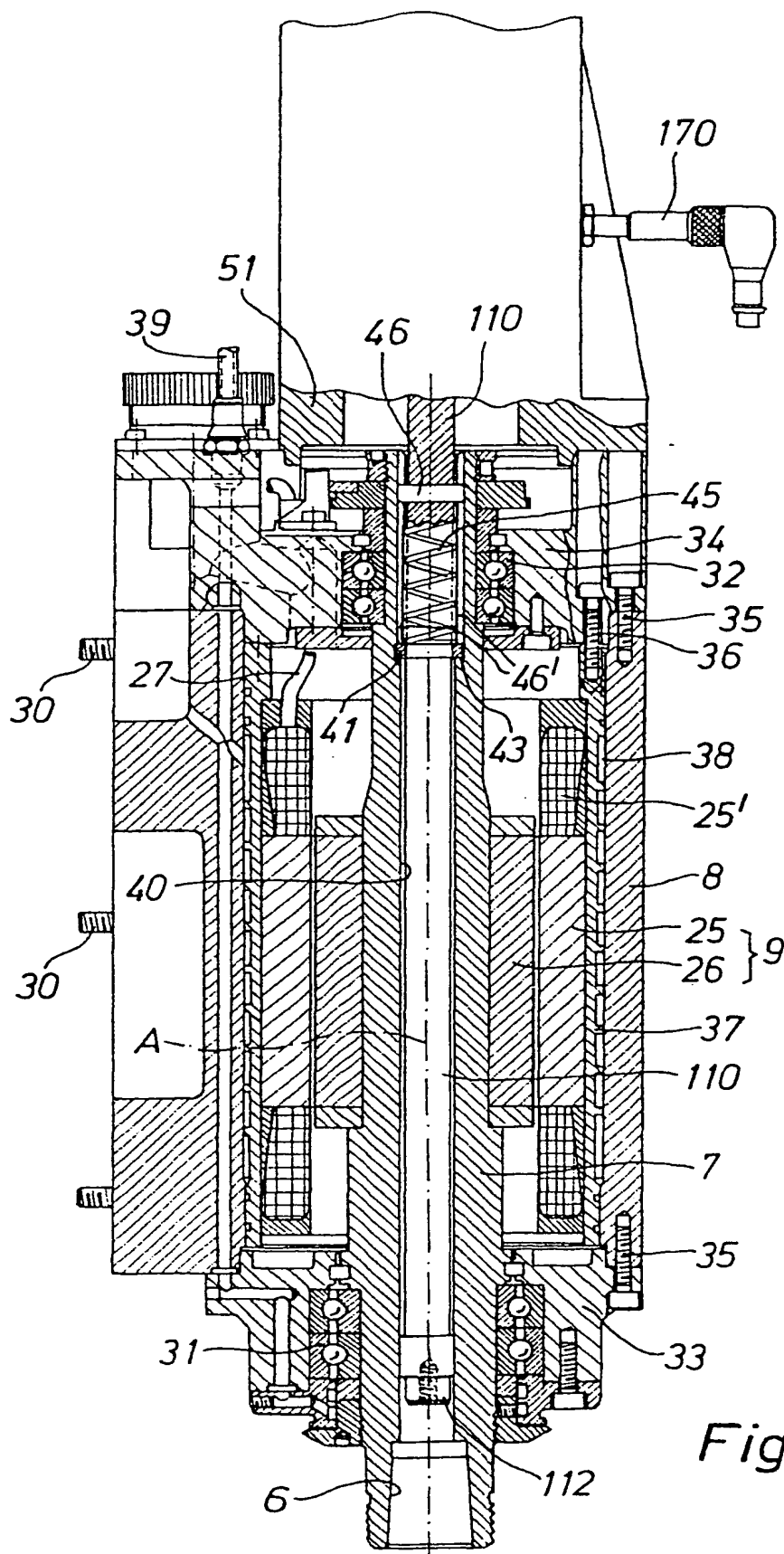


Fig. 4

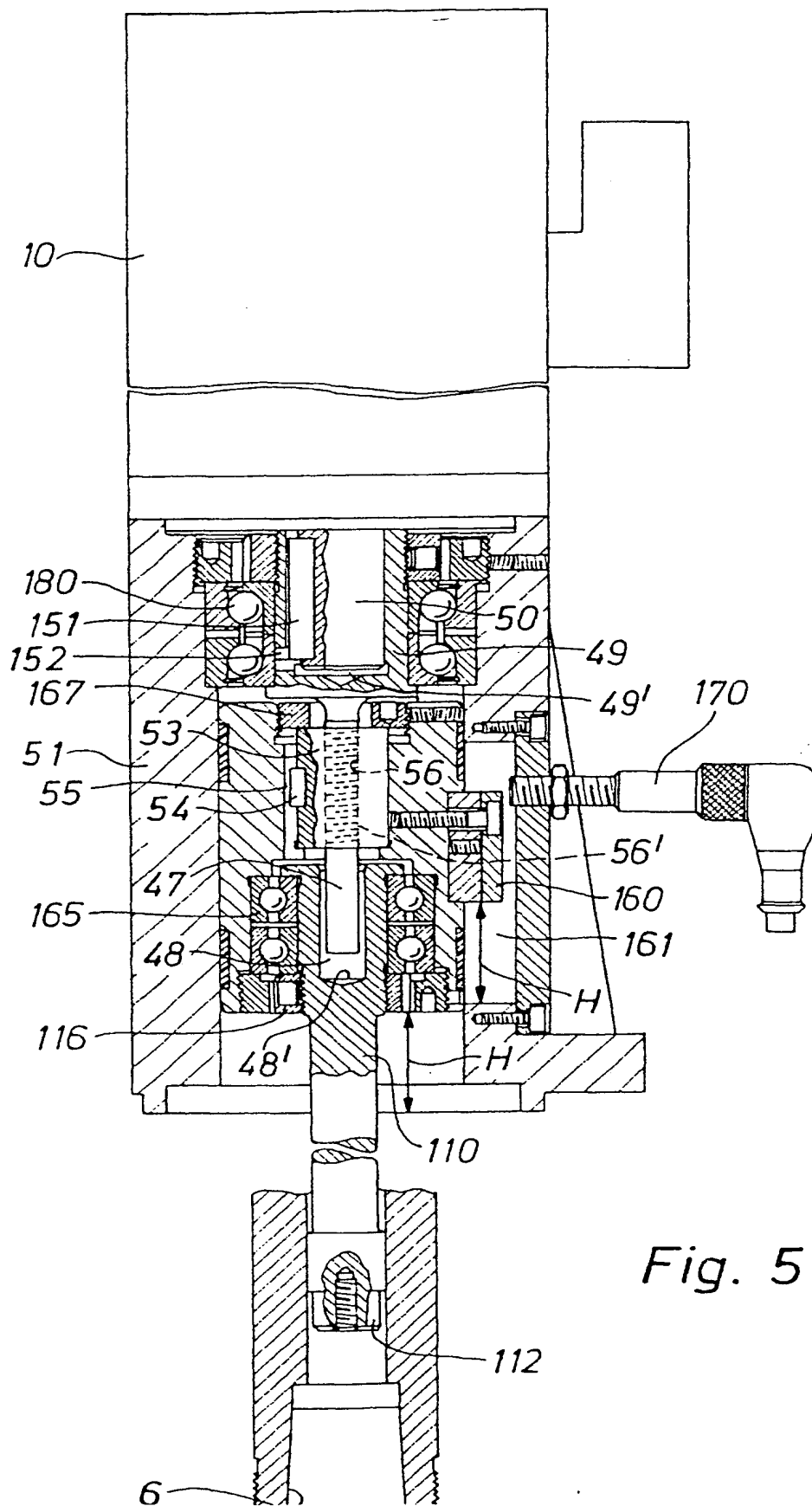


Fig. 5

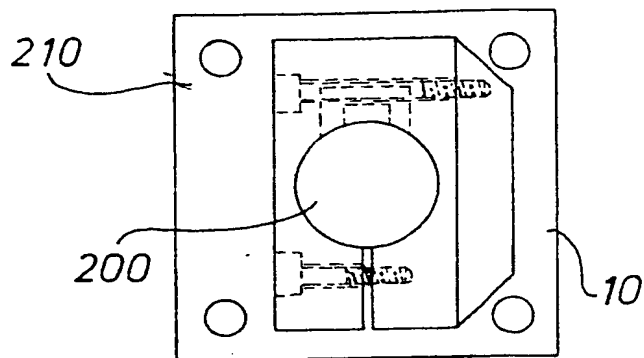
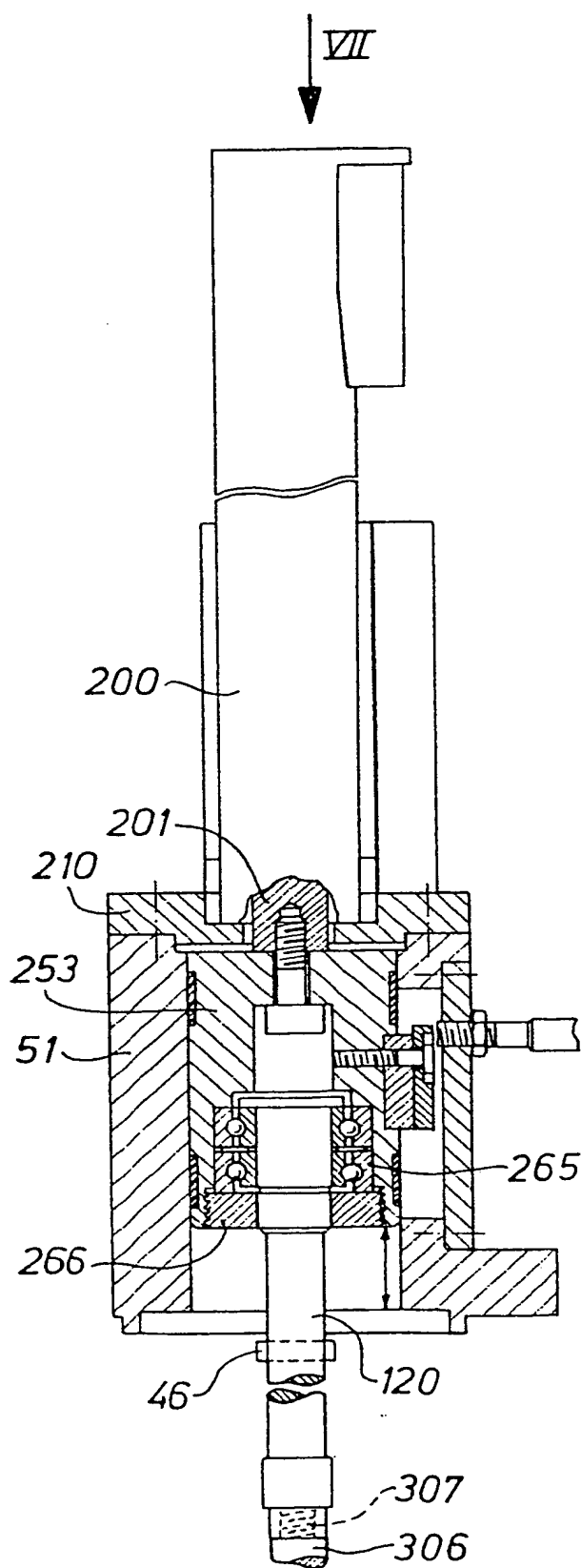


Fig. 7

Fig. 6

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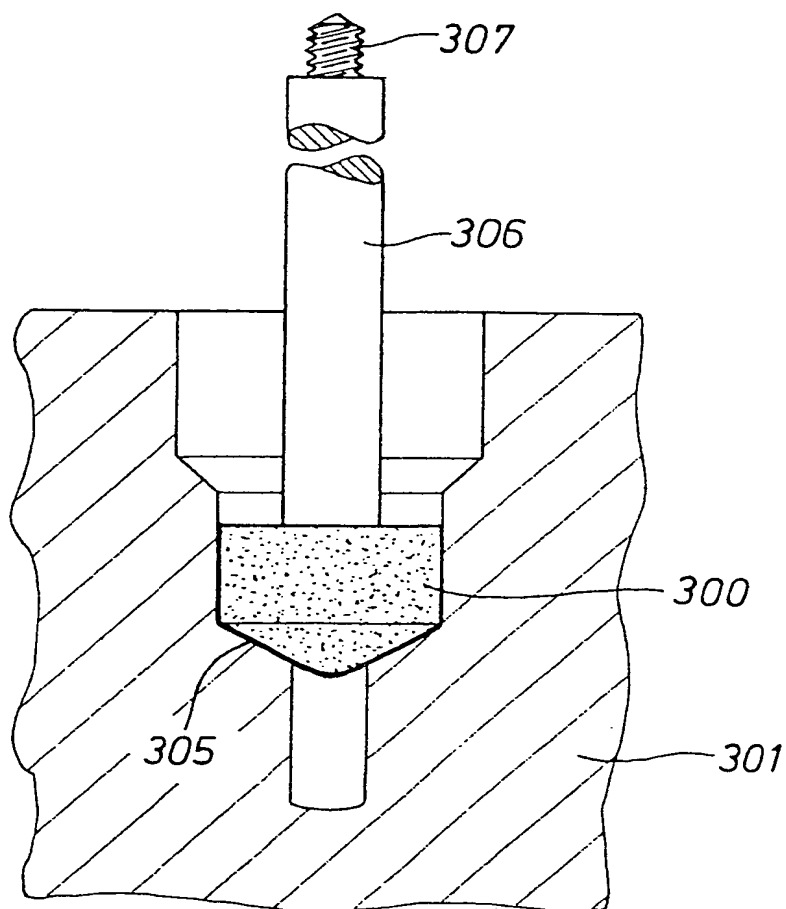


Fig. 8

Amended Claims

Filed with the International Office on July 04, 2003. Original claims 1-10 replaced by amended claims 1-3 (2 pages)

1. Machine for superfinishing tools through honing or precision grinding comprising a honing spindle which is disposed in a spindle housing and can be driven by an electromotor, whose stroke motion is effected by a linear motor whose moving part bears the spindle housing, and wherein a bar is disposed in the honing spindle which also rotates and can be axially displaced therein by a servomotor for widening a honing tool disposed on the honing spindle or as carrier of a grinding body, characterized in that the electromotor (9) is formed by a stator (25) which is integrated in the spindle housing, and a rotor (26) which can be rotated in the stator (25) in which the honing spindle (7) is disposed and the servomotor (10) is coaxially flanged to the end of the spindle housing (8).
2. Machine according to claim 1, characterized in that the driven shaft (50) of the servomotor (10) engages in a coupling piece (49) and rotates same, the coupling piece (49) comprising a plunger (47) provided with an outer thread (56') which engages in the inner thread (56) of an adjusting sleeve (53) which is axially displaced upon rotation of the coupling piece (49) due to engagement of the two threads (56, 56') and to which a further sleeve (52) is connected for axial displacement within the transmission housing (51) without rotating, wherein a connecting rod (110) which can be connected to said bar (10) is rotatably disposed in said sleeve (52).
3. Machine according to claim 2, characterized in that the delivery means comprises a linear motor (200) whose runner and stator are

round, wherein the runner is disposed in the stator and is connected to said sleeve (22).